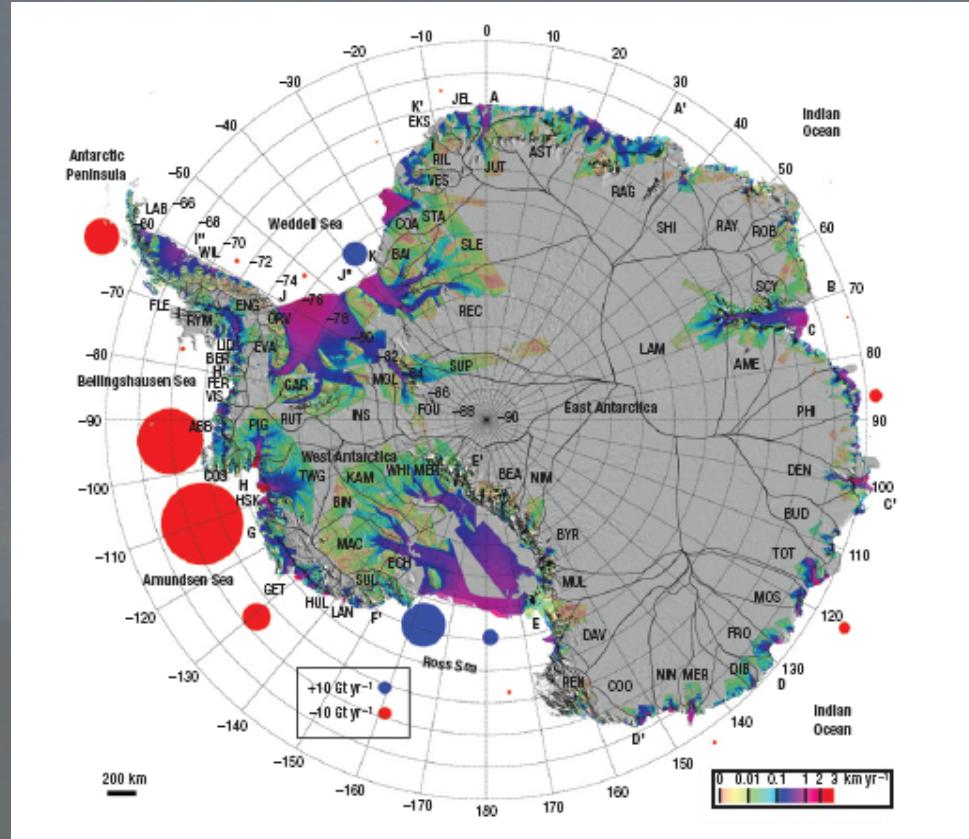


Estimating the Antarctic Freshwater contribution to the Southern Ocean in the ECCO2 Data Synthesis

Michael Schodlok



Antarctic Ice Mass Loss



E. Rignot

How much of the mass loss is contributed to basal melting?

How much of the mass loss to iceberg calving?

Do we capture the mass loss in the freshwater fluxes in our model?

Preconditioning to ice shelf disintegration?

What is the impact on the global ocean?

Circumpolar Freshwater Fluxes

Iceberg calving:

2016 Gt/a => 70 mSv (Jacobs et al. 1992)

Ice shelf basal melting (BRIOS):

906 Gt/a => 28 mSv (circumpolar) - Hellmer 2004

Modeling without iceshelves:

Sea ice thinning, increase of bottom salinity (Hellmer 2004)

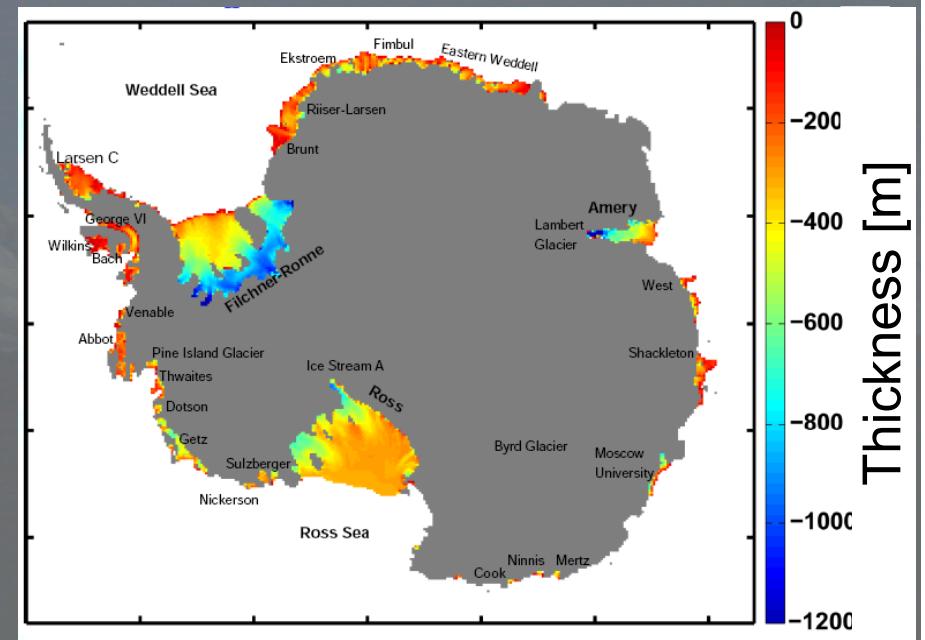
Implications beyond Antarctic Circumpolar Current (Hellmer et al., 2005
Schodlok et al., 2007)

Antarctic Ice Shelves in ECCO2

- ICESat/GLAS: DEM (E. Rignot)
- BEDMAP: Water Column Thickness
-> Firnlayer correction
=> Draft + Water Column Thickness = Cavity Bathymetry

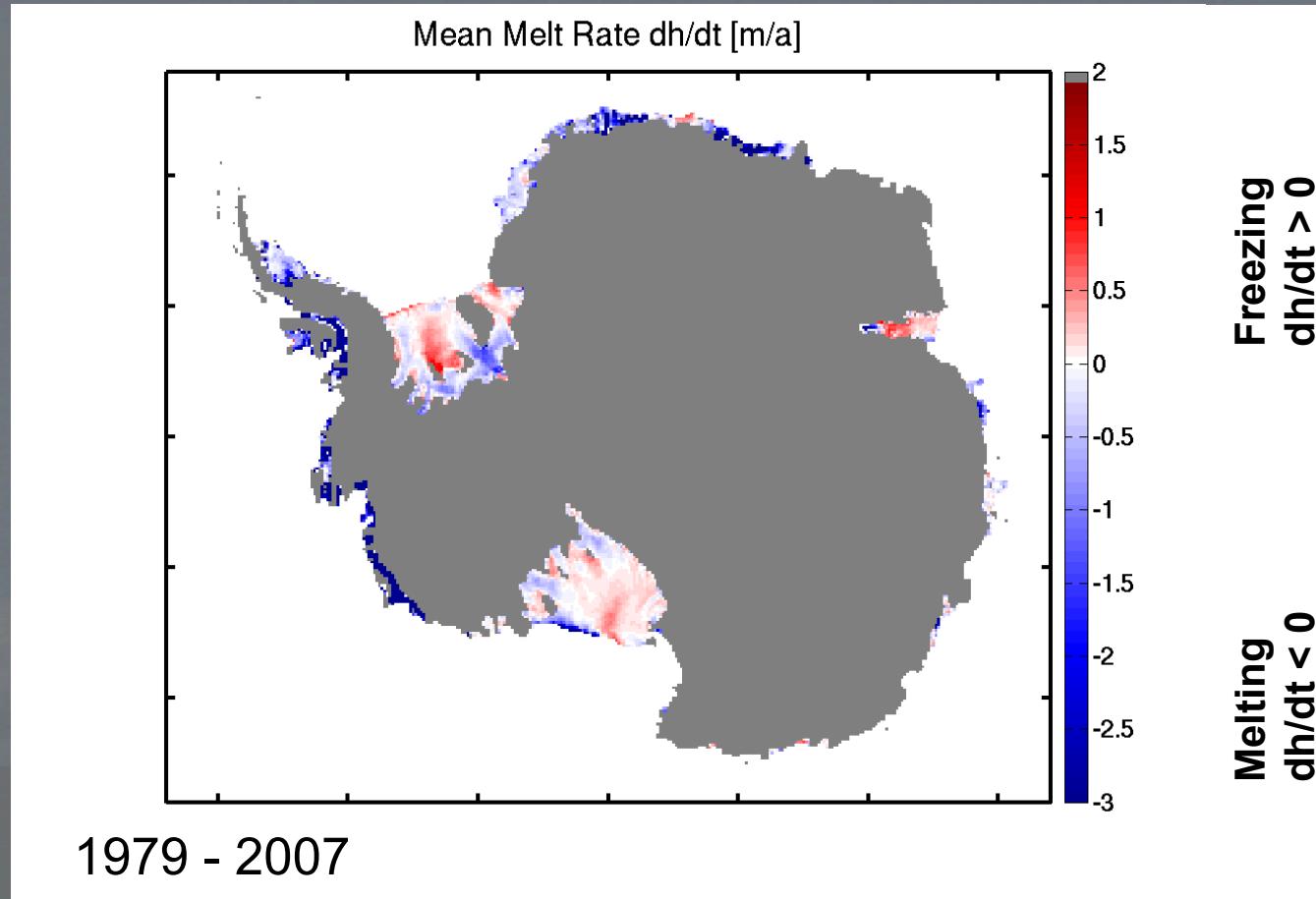
- Bathymetry:
Smith and Sandwell 2008, 1 min, v11.1

- Integration Period: 1979 - 2007
- OBCS: from optimised Cube78 solution
- Surface forcing: ERA40-ECMWF blend



Amery Data
Amundsen Sea bathymetry
WAIS/SGLOBEC

– Ben Galton-Fenzi (UTAS)
– Frank Nitsche (LDEO)
– Mike Dinniman (ODU)

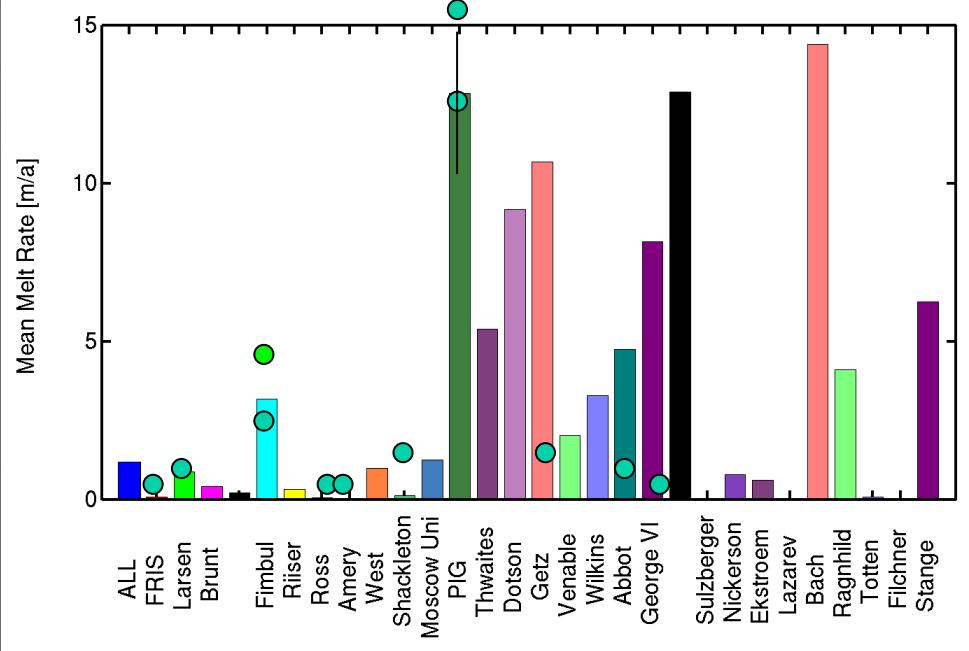
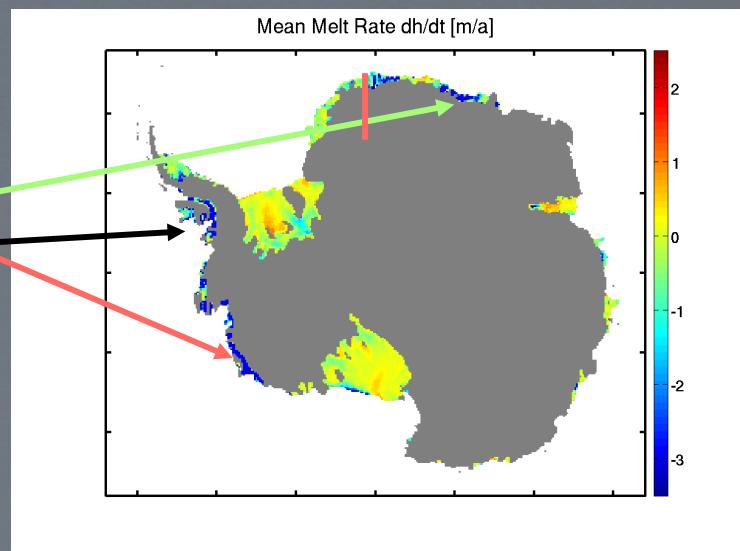
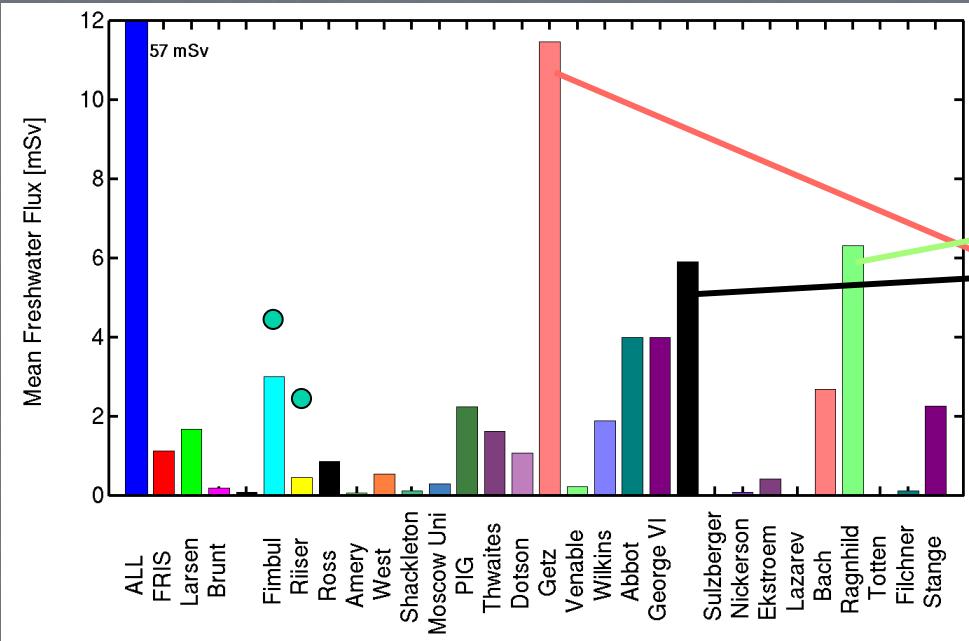


Strong melting in Amundsen – Bellingshausen Seas

Melting in Eastern Weddell Sea

Melting and freezing pattern in three major ice shelves

Motivation – ECCO2 Model – Freshwater Fluxes – Vertical Resolution – Summary



Circumpolar FWF

$57 \text{ mSv} \pm 7 \text{ mSv}$

28 mSv (Hellmer 2004)

$\sim 55 \text{ mSv}$ (E. Rignot)

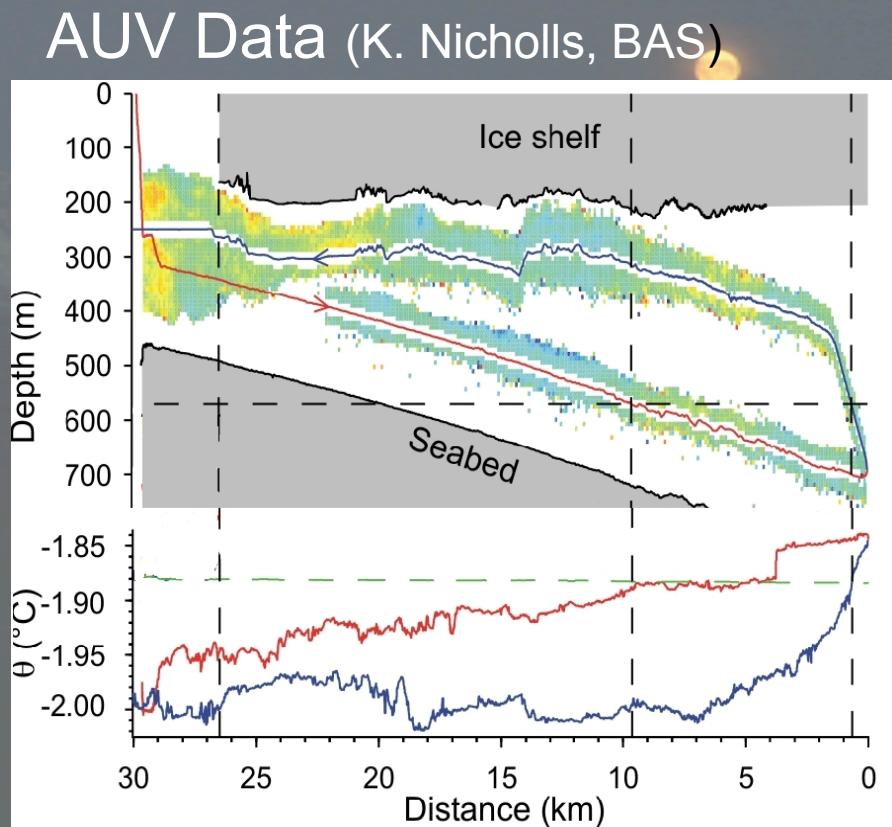
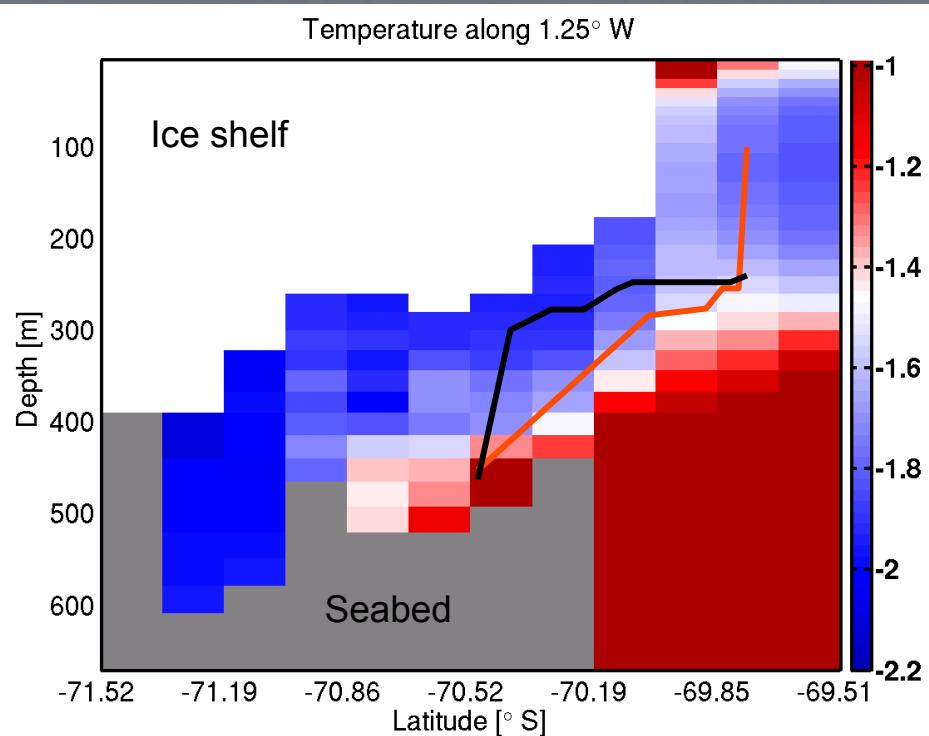
Weddell Sea:

3.51 mSv ECCO2

9.10 mSv (Timmermann, 2001)

Jacobs et al., 1996; Hellmer, 2004; Thoma, 2005;
Smedsrød et al., 2006; Payne et al., 2007

Motivation – ECCO2 Model – Freshwater Fluxes – Vertical Resolution – Summary

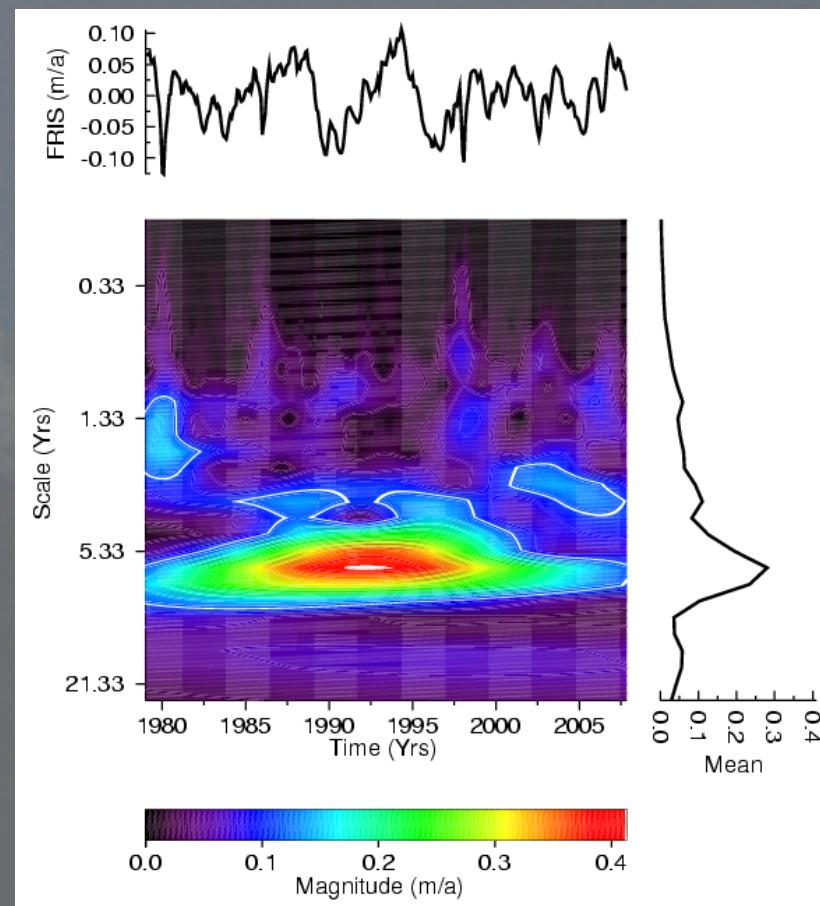
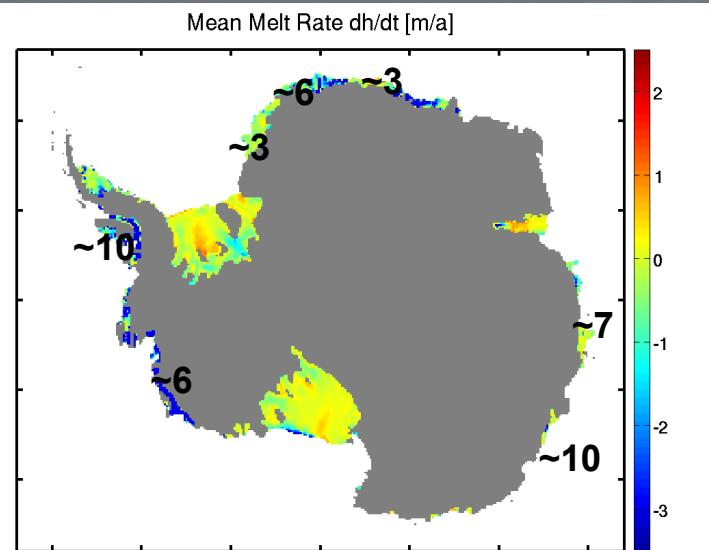


Wavelet Analysis:

maximum spectral power at around 1 year – seasonal cycle

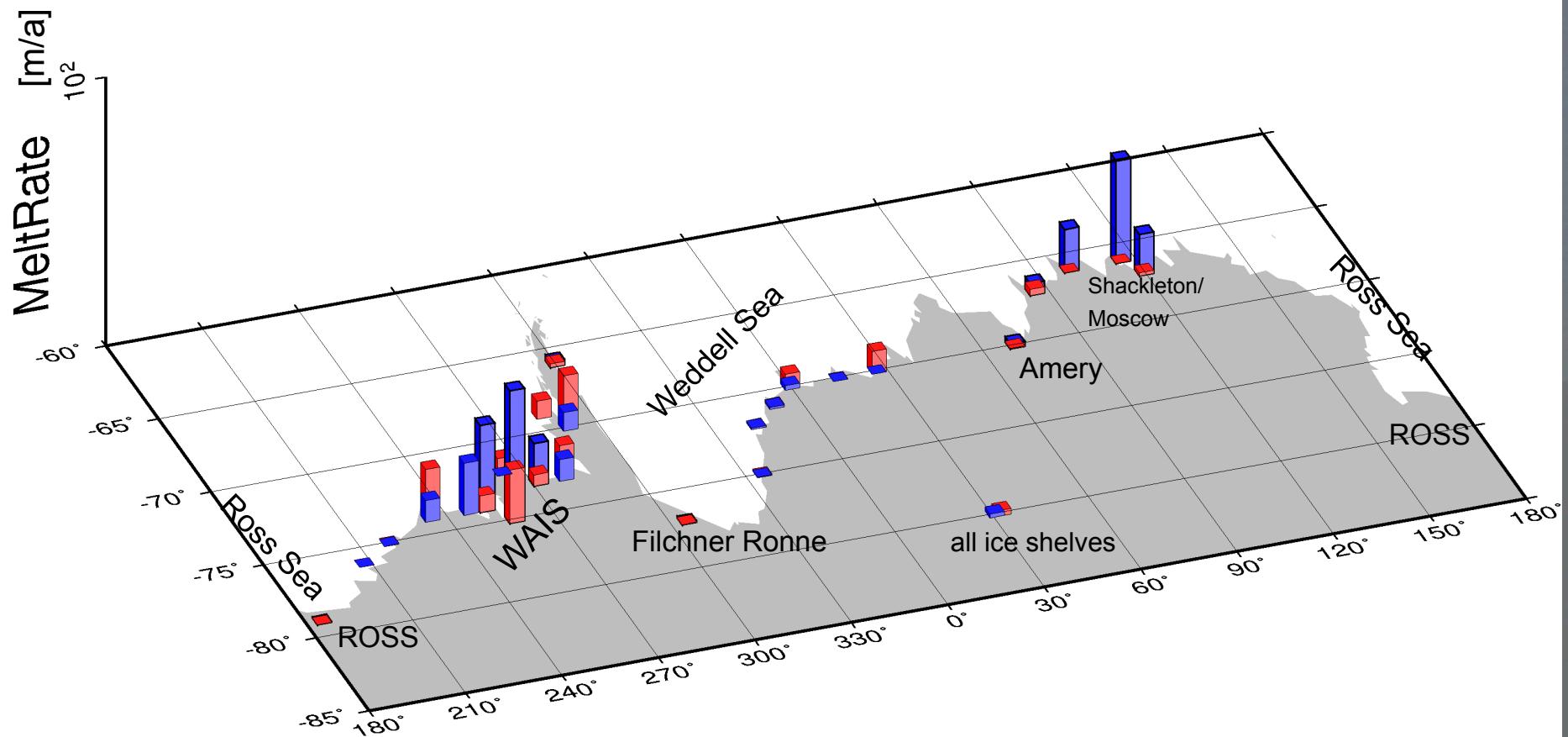
the 7 year mode dominates during the 90ties for major ice shelves

correlation to SOI or SAM?

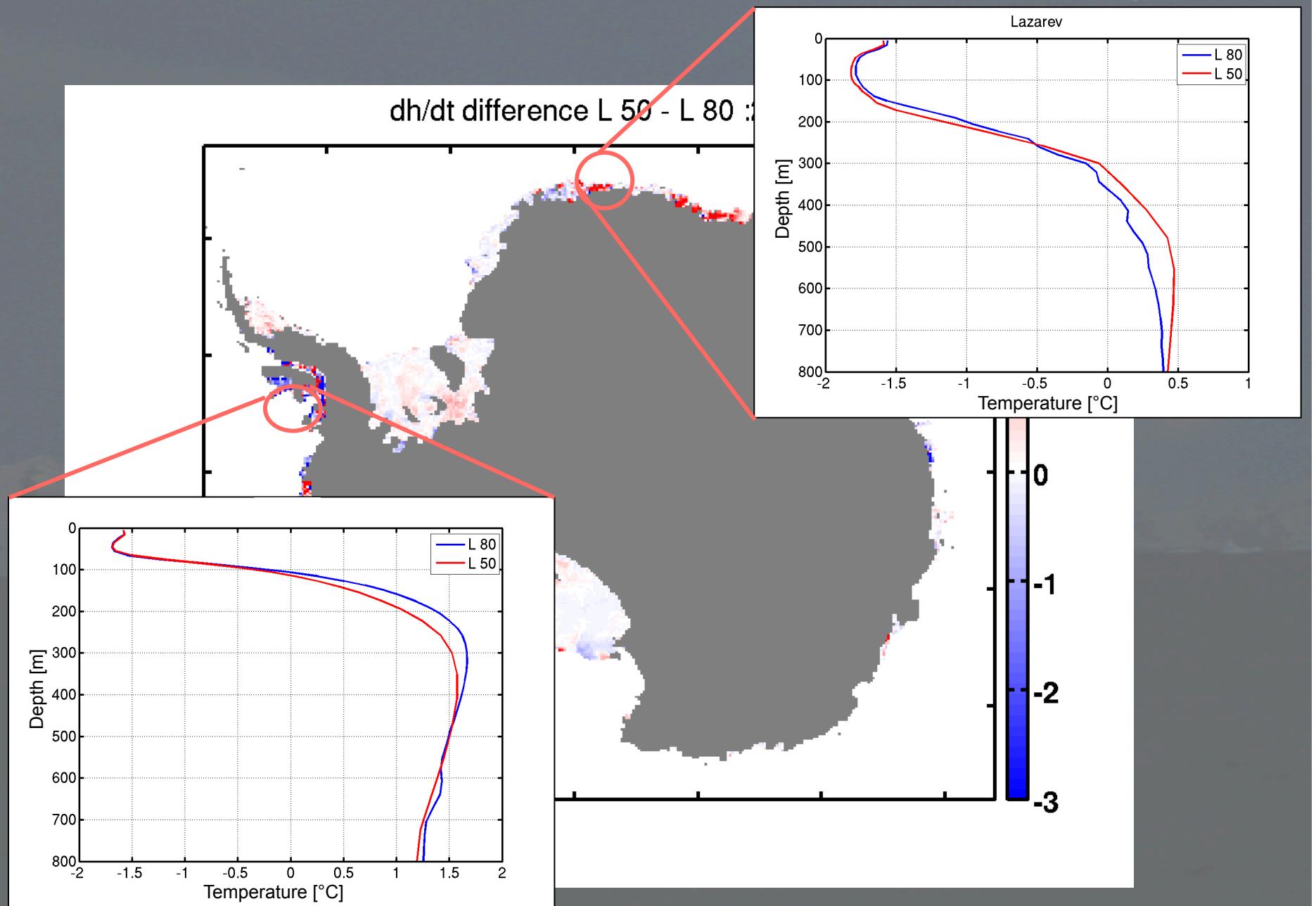


Melt Rate dh/dt 2004

- ICESAT/GLAS observation estimates (E Rignot)
- ECCO2 Model estimates

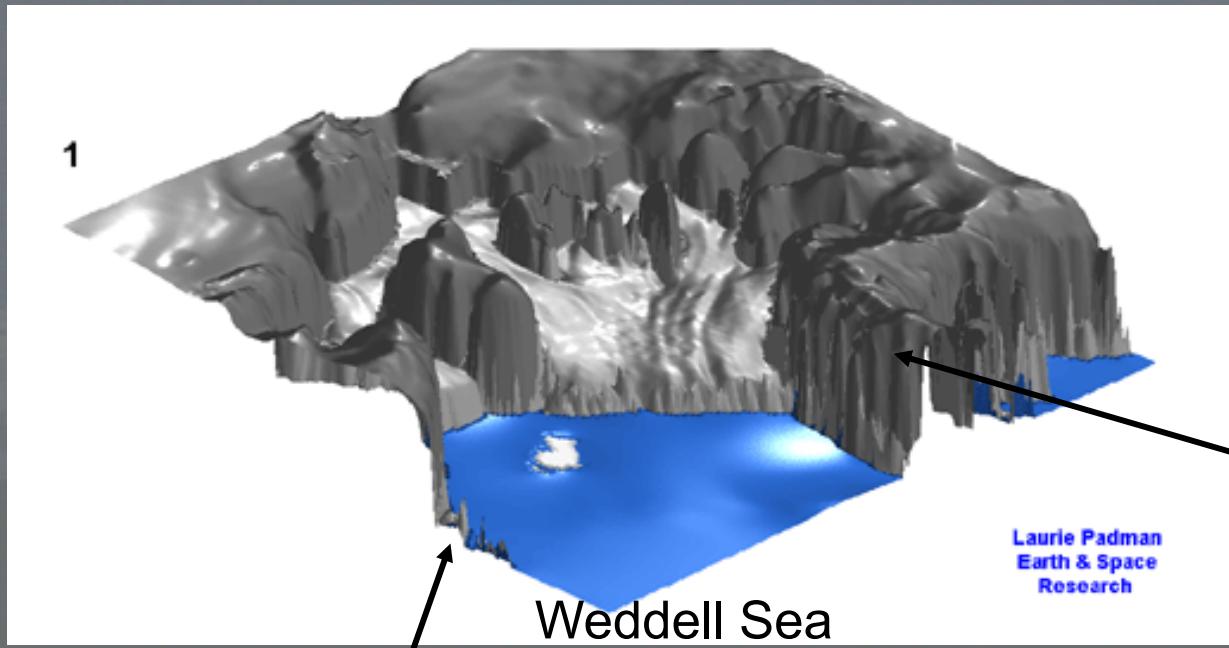


Motivation – ECCO2 Model – Freshwater Fluxes – Vertical Resolution – Summary



Wishlist: ECCO2 Tides and ice shelves

Filchner Ronne Ice Shelf



Ant. Peninsula
70°W

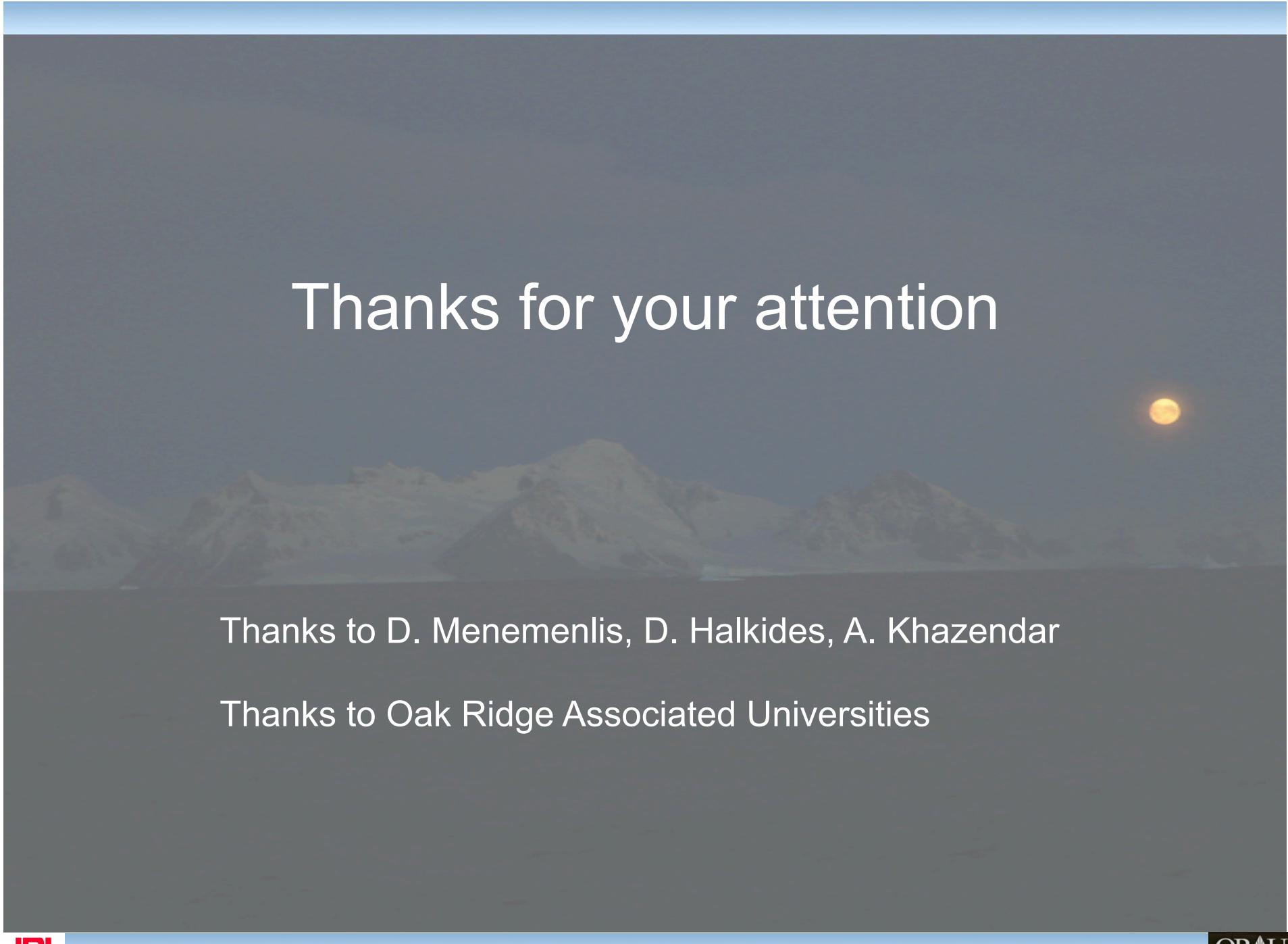
Weddell Sea

Kapp Norvegia
15°W

Tidal Range: ~ 5m at Grounding Line

Summary and Outlook

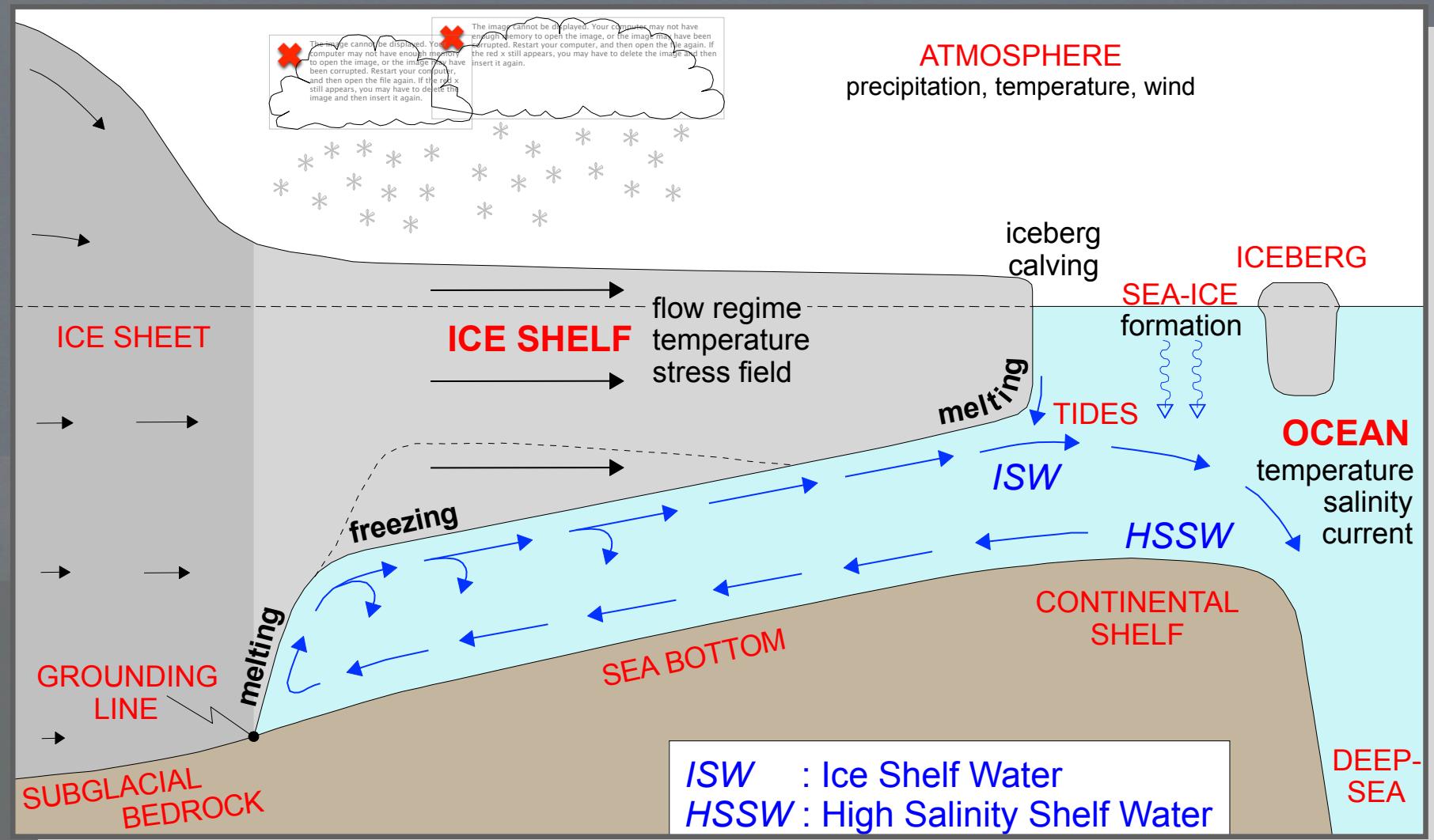
- FWF doubled compared to previous circumpolar estimates
- similar order of magnitude to satellite derived estimates with large deviations in the WAIS and Shackleton IS areas.
- vertical Resolution: increase melting in WAIS region, decrease in the eastern Weddell
- implementation in global ECCO2 model run (cube86 underway)
- optimization for JRA25 surface forcing (underway)
- correlate dominant periods to SAM/SOI



Thanks for your attention

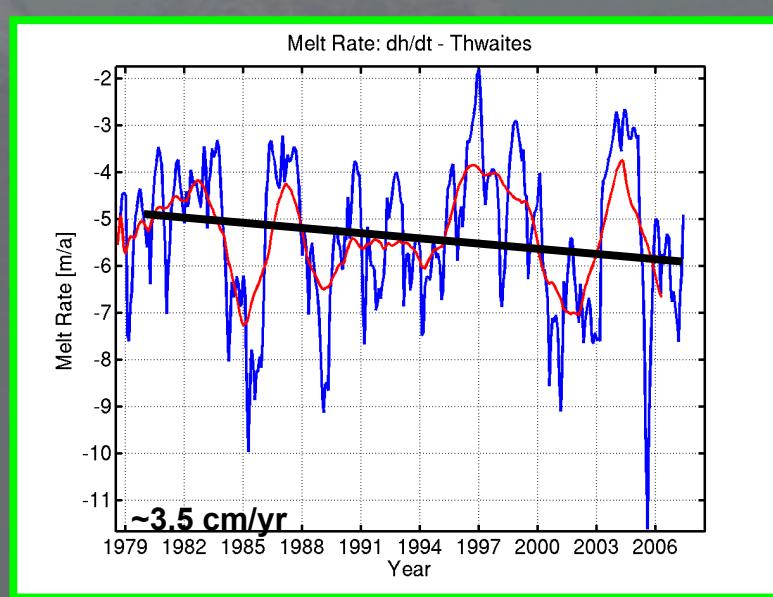
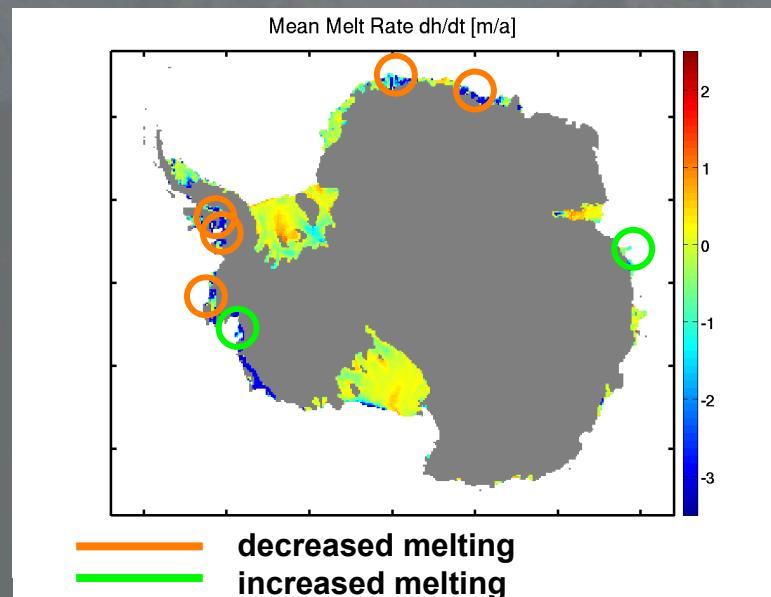
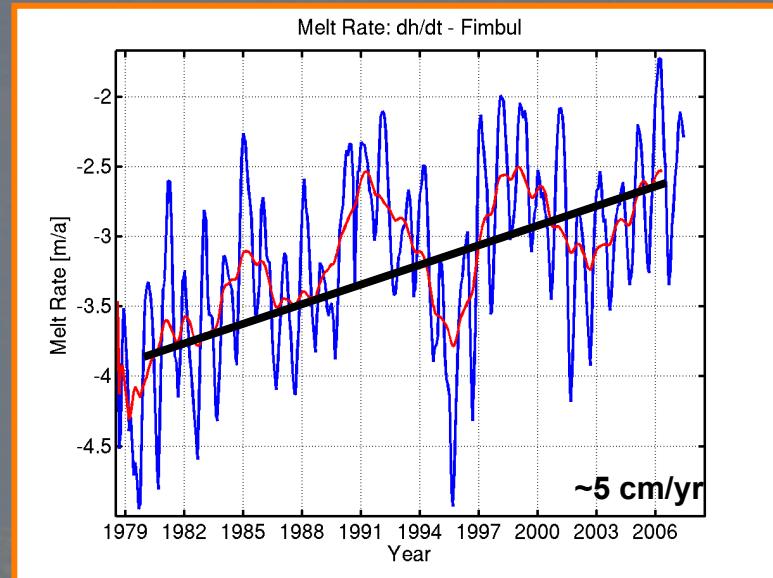
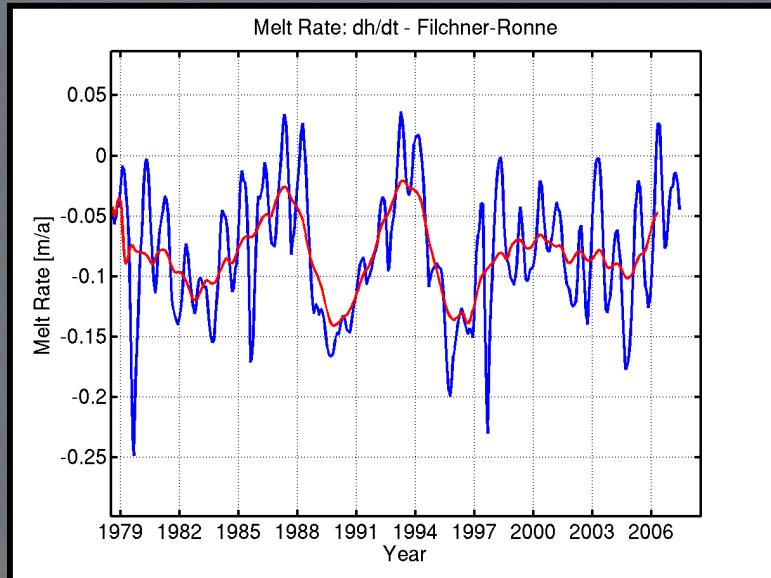
Thanks to D. Menemenlis, D. Halkides, A. Khazendar

Thanks to Oak Ridge Associated Universities



Klaus Grosfeld

Circumpolar Freezing and Melting Trends



A widely accepted model of ice shelf – ocean interaction

uses a three-equation approach
considering the heat and salt budget
of the ice-ocean boundary layer
(Holland and Jenkins, 1999)

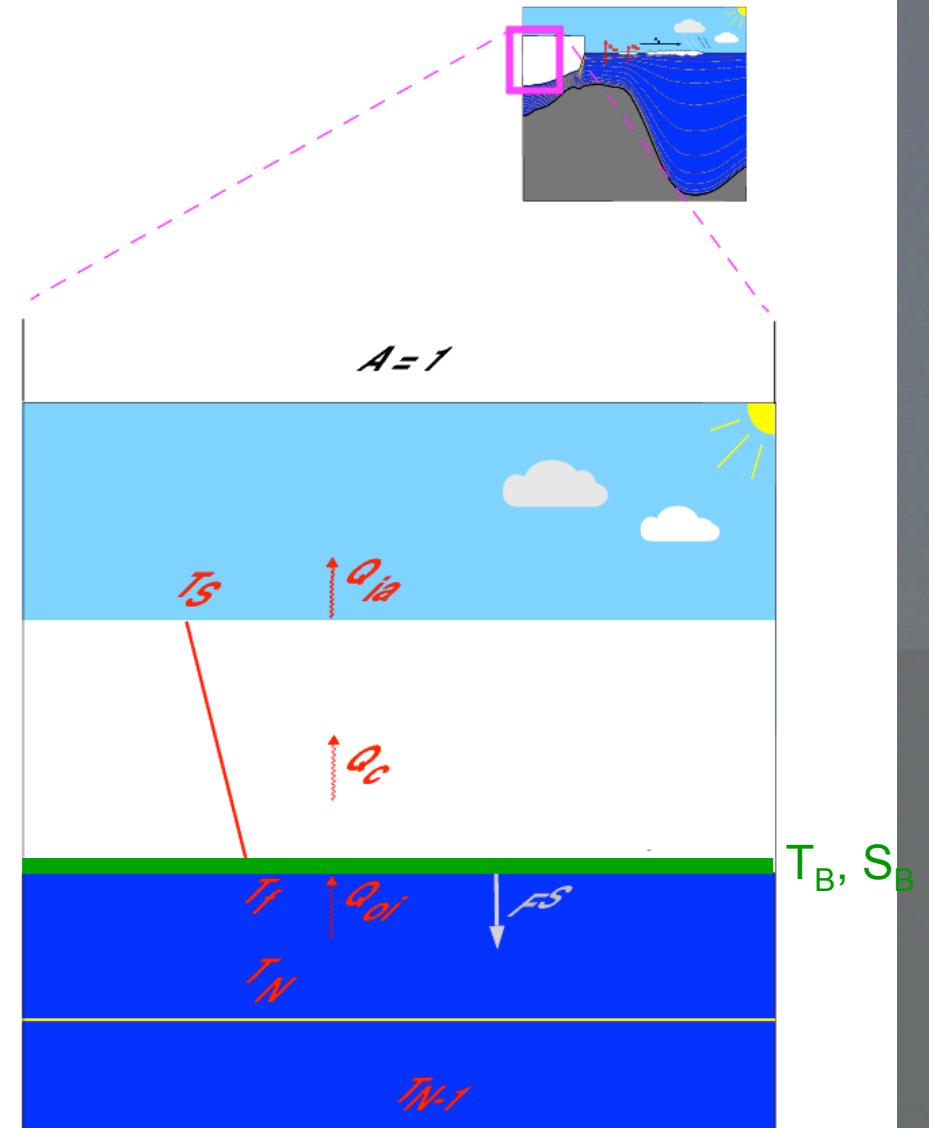
$$1. \frac{\partial h}{\partial t} = \frac{Q_{ia} - Q_{oi}}{\rho_i L_i} \quad Q_{oi} = \rho_w c_{p,w} \gamma_T (T_N - T_B)$$

$$2. \quad Q_{oi}^S = -\rho_i S_B \frac{\partial h}{\partial t} = \rho_w \gamma_s (S_N - S_B)$$

$$3. \quad T_B = T_f(S_B, h), \text{ linearized}$$

with diagnostic boundary layer salinity S_B ,
and different choices for γ_T (z.B. $\gamma_T(u^*)$
with 'real' u^* or pseudo-tidal velocities)

Note that $h = \text{const}$



Meridional Overturning with and without ocean ice shelf interaction (IS)

without IS:

9.30 Sv at 28.3 kg/m^3
 -19.43 Sv at 27.7 kg/m^3

with IS:

5.62 Sv at 28.2 kg/m^3
 -20.91 Sv at 27.5 kg/m^3

